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SCIENTIFIC ARTICLE

Comparison of the conventional CMAC and the D-blade CMAC with the direct laryngoscopes in simulated cervical spine injury—a manikin study

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KEYWORDS
CMAC videolaryngoscope;
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Abstract
Background: CMAC videolaryngoscope has recently been introduced for videoscope guided intubation. The aim of our study was to compare and evaluate the efficacy of the conventional blade and the angulated D blade of the CMAC videolaryngoscope with the direct laryngoscopes in simulated cervical spine injury patients on the airway manikin.
Materials and methods: Following power analysis, 33 resident doctors were enrolled to perform endotracheal intubation using all the 4 different laryngoscopes namely the Macintosh laryngoscope, McCoy laryngoscope, conventional CMAC videolaryngoscope and the D blade of the CMAC videolaryngoscopes on the airway manikin in simulated cervical spine injury. The demographic variables of the resident doctors were recorded. The outcomes measured included vocal cord visualization (Cormack–Lehane grading), time taken to intubate, number of attempts for successful intubation and optimizing maneuvers required.
Results: The use of indirect videolaryngoscopes resulted in better glottic visualization in comparison to the direct laryngoscopes (CL-I) in 20/33 (60.6%) in the Macintosh group, 24/33 (72.7%) in McCoy group, 30/33 in (90.9%) in Vlc group and 32/33 (96.9%) in Vld group. The time taken to intubate averaged to 15.54 ± 2.6 in Macintosh group, 18.90 ± 4.47 in McCoy group, 20.21 ± 7.9 in Vlc group and 27.42 ± 9.09 in Vld group. The 1st attempt intubation success rate was 84.8% (Macintosh), 72.7% (McCoy), 90.9% (Vlc) and, 78.7% (Vld).
Conclusions: The overall performance of the conventional CMAC blade proved to be the best when compared with the D-blade CMAC, Macintosh blade and the McCoy blade for intubation in simulated cervical spine patients by anesthesia residents.

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PALAVRAS-CHAVE
Videolaringoscópio C-MAC;
C-MAC D-blade;
Simulação de lesão da coluna cervical;
Estudo em modelo

Comparação do C-MAC convencional e C-MAC D-blade com laringoscópios diretos em simulação de lesão da coluna cervical—estudo em modelo

Resumo
Justificativa e objetivo: O videolaringoscópio C-MAC foi recentemente introduzido para orientar a intubação. O objetivo deste estudo foi comparar e avaliar a eficácia do laringoscópio C-MAC de lâmina convencional e C-MAC de lâmina angulada (D-blade) com laringoscópios diretos em simulação de pacientes com lesão de coluna cervical usando modelo de vias aéreas.
Materiais e métodos: Após a análise do poder do estudo, 33 médicos residentes foram inscritos para realizar intubações endotraqueais, usando todos os quatro laringoscópios diferentes: laringoscópio Macintosh, laringoscópio McCoy, videolaringoscópios C-MAC convencional e C-MAC D-blade em modelos de vias aéreas com simulação de lesão da coluna cervical. As variáveis demográficas dos médicos residentes foram registradas. Os resultados avaliados incluíram visualização das pregas vocais (classificação de Cormack-Lehane), tempo necessário para intubar, número de tentativas para intubação bem-sucedida e manobras de otimização necessárias.
Resultados: O uso de laringoscópios indiretos resultou em melhor visualização da glote em comparação com os laringoscópios diretos (CL-I) em 20/33 (60,6%) no grupo Macintosh, 24/33 (72,7%) no grupo McCoy, 30/33 (90,9%) no grupo Vlc e 32/33 (96,9%) no grupo Vld. A média do tempo necessário para entubar foi de 15,54 ± 2,6 no grupo Macintosh, 18,90 ± 4,47 no grupo McCoy, 20.21 ± 7,9 no grupo Vlc e 27,42 ± 9,09 no grupo Vld. A taxa para a primeira tentativa de intubação bem-sucedida foi de 84,8% (Macintosh), 72,7% (McCoy), 90,9% (Vlc) e 78,7% (Vld).
Conclusão: O desempenho geral da lâmina do C-MAC convencional mostrou ser melhor quando comparado com o das lâminas do C-MAC D-blade, Macintosh e McCoy para intubação em modelo de simulação de lesão da coluna cervical realizada por médicos residentes de anestesia.

Introduction

Ability to intubate the trachea and secure the airway is one of the life saving skills to be acquired by all the training medical students. Failure to do so can result in hypoxia, airway trauma, oesophageal intubation and even cardiorespiratory arrest.[1] Successful intubation requires proper alignment of the oro-pharangeal-laryngeal axis.[2] However, in cervical spine patients this alignment is not possible resulting in increased risk of failed intubations.[3–6] Due to morbidity and mortality associated with failed intubation,[7,8] anesthetists are constantly improvising on newer means to reduce the incidence of failed intubations.

Till date, the curved Macintosh blade is commonly being used by the anesthetists for airway management of such patients.[9] Over the years many different types of laryngoscopes have been introduced to reduce the incidence of these complications. McCoy laryngoscope with its hinged tip has shown to provide better glottis visualization in comparison to the Macintosh blade.[10–12]

In the past few years we have witnessed an increasing use of videolaryngoscopes for the management of the patients with difficult intubation.[13,14]

CMAC videolaryngoscope (Karl Storz, Tuttligen, Germany) has been recently introduced for videoscope guided intubation. This portable videolaryngoscope comes with the original Macintosh blade made of steel along with the CMOS digital camera and high power LED. Due to the presence of the normal Macintosh blade CMAC (Vlc) provides both direct and indirect glottic visualization.[15,16] CMAC-D blade (Vld) videolaryngoscope is a newer addition to the CMAC system. In comparison to the conventional CMAC blade, the D blade has an inbuilt angulation.[17] Due to the highly pronounced curvature, it provides a better view of the laryngeal structures.

Till date, no study has compared the two blades of the CMAC videolaryngoscope with the Macintosh and the McCoy laryngoscopes.

The aim of our study was to compare and evaluate the efficacy of the conventional blade and the angulated D blade of the CMAC videolaryngoscope with the direct laryngoscopes in simulated cervical spine injury patients on the airway manikin.

Materials and methods

This study was conducted over a period of 3 months from January 2012 to March 2012.

As this study did not involve any human subjects, approval from the institutional ethics review committee was not taken.

Participation of the resident doctors was on voluntary basis. Forty resident doctors with a minimum of 6 months anesthesia training experience were enrolled in the study.

Before the commencement of the study, participants were given a step by step demonstration on the use of CMAC videolaryngoscopes individually by a trained investigator. The investigator had an experience of more than 50 intubations with all devices used in the study protocol. This was followed by a brief practice session on the use of

the two different blades of the CMAC videolaryngoscope on the airway manikin in its normal state. Only thirty-three residents who succeed to intubate with all the four blades on two consecutive attempts were enrolled in the study.

The airway manikin (Ambu® Airway Management Trainer) with cervical collar in situ was used in the study for simulated cervical spine injury. Size 3 blade of the Macintosh, McCoy and the CMAC videolaryngoscope were used in the study. A 7 mm cuffed endotracheal tube mounted on a well lubricated angulated stylet was kept prepared for intubation.

Intubation was performed by all the resident doctors using all the 4 different laryngoscopes namely the Macintosh laryngoscope, McCoy laryngoscope, conventional blade C-MAC videolaryngoscope and the D blade of the CMAC videolaryngoscopes.

The sequence of the devices used for intubation was randomized using slip in a box technique.

Demographic data of the resident doctors including the age, duration of experience, and number of intubations performed with Macintosh laryngoscope were recorded.

The primary outcome was the duration of time taken for successful tracheal intubation. The time taken for successful intubation was defined as the time taken for of the insertion of the blade between the teeth, till the confirmation of the tube by connecting it to the AMBU bag and inflating the lungs. We used the similar technique for both the direct and indirect laryngoscopes to standardize the protocol. The number of optimization maneuvers required (use of a bougie, BURP or backward-upward-rightward pressure on larynx, second assistant) to aid tracheal intubation, and the Cormack and Lehane grade at laryngoscopy were noted. A failed intubation attempt was defined as inability to intubate after three laryngoscopic attempts or within 120 s.

Statistical analysis

Graphpad Prism 6 (by Graphpad Software Inc. Avenida de la Playa La Jolla, CA 92037, USA) was used to analyze the data. The data for duration of successful tracheal intubation, number of intubation attempts, Cormack Lehane laryngoscopic view and number of optimizing maneuvers were analyzed using repeated measures ANOVA. Post hoc analyses among individual groups were carried out using Tukey–Kramer Multiple Comparisons Test. A p value of <0.05 was considered as significant.

Results

Demographic variables of the participants (Table 1)

A total of 33 residents enrolled completed the study. All residents had performed more than 100 intubations with the Macintosh laryngoscope. The residents were familiar with the use of McCoy laryngoscope, especially in situations of difficult airway.

However, none of them had any experience with the CMAC videolaryngoscope.

The mean age, the years of clinical experience and number of intubations performed with Macintosh laryngoscope are given in Table 1.

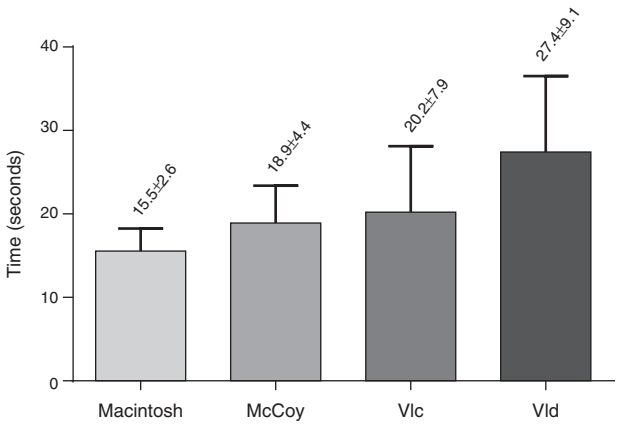

Figure 1 Time taken to intubate using Macintosh, McCoy, Vlc and Vld blades.

Time taken to Intubate (Fig. 1, Table 2)

Time taken to intubate using either of the blades of the CMAC was prolonged in comparison to the Macintosh laryngoscope ($p < 0.05$ with Vlc and $p < 0.001$ with Vld). However time taken to intubate using McCoy laryngoscope was comparable with the Macintosh blade. Time taken to intubate using the D blade CMAC was prolonged in comparison to the McCoy laryngoscope. Conventional blade CMAC was comparable to McCoy laryngoscope with regard to time taken to intubate.

Laryngoscopic view (Tables 2 and 3)

Cormack Lehane grading system was used to grade the laryngoscopic view obtained on the 1st intubation attempt. Statistically significant improvement in the laryngoscopic view was seen with Vlc and Vld in comparison the Macintosh laryngoscope and the McCoy laryngoscope. McCoy laryngoscope provided slight improvement in the laryngoscopic view in comparison to the Macintosh laryngoscope but the difference was not statistically significant.

Table 1 Demographic variables of the residents.

Number of residents	Mean age (years)	Clinical experience (years)	No of intubations (Macintosh)
33	24 (3)	1.8 (1)	120 (100–300)

Data expressed as number, mean (SD) or median (range).

Table 2 Results of tracheal intubation using Macintosh, McCoy, conventional CMAC blade and the D-blade of CMAC in cervical spine scenario in manikin.

	Macintosh	McCoy	Vlc	Vld	*p*-Value
Time for successful intubation (s)	15.55 ± 2.69	18.91 ± 4.47[a]	20.21 ± 7.9[a]	27.42 ± 9.1[a,b]	$p < 0.0001$
Laryngoscopic view (Cormack–Lehane)	1.39 ± 0.49	1.27 ± 0.45	1.09 ± 0.29[a,b]	1.03 ± 0.17[a,b]	$p = 0.001$

Data expressed as mean ± SD.
[a] $p < 0.05$ when compared with Macintosh Laryngoscope.
[b] $p < 0.05$ when compared with McCoy Laryngoscope.

Number of intubation attempts (Table 3)

The percentage of 1st attempt successful intubation was highest with Vlc and lowest with McCoy laryngoscope. However these differences were not statistically significant.

Number of maneuvers required (Table 3)

Significantly less number of optimizing maneuvers were required by the Vlc and Vld when compared with the Macintosh laryngoscope. McCoy laryngoscope was comparable to the Macintosh laryngoscope with regard to the number of optimizing maneuvers required.

Discussion

Inability to successfully secure the airway is one of the most dreaded complications of anesthesia. Intubation of the trachea involves two basic components – exposure of the glottic opening and negotiation of the endotracheal tube through the vocal cords.

Direct laryngoscopy requires head flexion and neck extension for the alignment of the oro-pharangeal-laryngeal axis to obtain glottis exposure. Manual in line stabilization in cervical spine patients prevents neck movements, thereby resulting in poor glottic exposure.[18–20] This has led to increased morbidity in cervical spine patients due to the difficulties encountered in the airway management of such patients.[21,22]

Various alternative devices have been developed to reduce the incidence of such complications. McCoy laryngoscope with a distal levering tip requires less force for the alignment of the axis and improves the laryngoscopic view.[23]

Recently, indirect laryngoscopes are gaining popularity in the management of patients with compromised airway. These devices incorporate video or optic technology for the visualization of the trachea without alignment of the oral, pharangeal and laryngeal axis.[24] CMAC videolaryngoscope in manikin models have shown to provide better visualization of the glottis and faster intubation time.[25] In trials conducted on human subjects CMAC has shown its superiority over angulated videolaryngoscopes.[26]

Initial evaluation of the CMAC-D blade videolaryngoscope has shown its superiority over the Macintosh laryngoscope.[27] However, there is paucity of literature on the use of the CMAC-D blade videolaryngoscope in cervical spine patients.

We had designed the study to evaluate the efficacy of recently introduced D-blade CMAC with the conventional CMAC and direct laryngoscopes.

In the present trial, greater prolongation of the intubation time was shown using the CMAC-D blade videolaryngoscope in comparison to the Macintosh, McCoy and the CMAC videolaryngoscope. Lesser amount of time taken by the direct laryngoscopes can be attributed to the familiarity of the participants to the Macintosh and the McCoy laryngoscopes. The difference in the intubation time between the C MAC and the CMAC-D blade videolaryngoscope can be due to the difference in the shape of the two devices. The conventional CMAC incorporates the normal Macintosh laryngoscope while the CMAC-D blade videolaryngoscope has

Table 3 Results of attempts of tracheal intubation and optimizing maneuvers used.

Parameter assessed	Macintosh	McCoy	Vlc	Vld
No of intubation attempts				
1	29 (87.9%)	24 (72.7%)	30 (90.9%)	26 (78.7%)
2	4 (12.1%)	9 (27.3%)	3 (9.1%)	7 (21.2%)
Optimizing maneuvers				
Not used	24 (72.7%)	28 (84.8%)	32 (96.9%)	30 (90.9%)
Used	9 (27.3%)	5 (15.2%)	1 (3%)[a]	3 (9.1%)[a]
Laryngoscopic view (CL grading)				
I	20/33 (60.6%)	24/33 (72.7%)	30/33 (90.9%)[a]	32/33 (96.9%)[a]
II	13/33 (39.3%)	9/33 (27.2%)	3/33 (9%)[a]	1/33 (3%)[a]

Data expressed as number (percentage).
[a] $p < 0.05$, in comparison to Macintosh.

Figure 2 Figure showing the conventional CMAC blade and the D-blade CMAC videolaryngoscope.

an inbuilt pronounced angulation (Fig. 2). This increase in angulation from 18° in CMAC (size 3) to 40° in the D blade CMAC necessitates the use of a curved stylet and results in greater manipulation in negotiating the tube through the vocal cords.

CMAC and the CMAC-D blade videolaryngoscope provided better visualization of the glottis opening in comparison to the direct laryngoscopes. This finding is supported by the earlier trials comparing the indirect laryngoscopes with the direct laryngoscopes on manikin.[28]

We would like to highlight that in comparison to the CMAC, the CMAC-D blade videolaryngoscope provided better glottis visualization as graded by the Cormack–Lehane laryngoscopic view. This difference again can be explained by the increased angulation of the D blade.

In our study the newer D-blade undoubtedly provided the best laryngoscopic view; however our residents had difficulty in negotiation of the tube. Similar problem has earlier been encountered with the other available videolaryngoscopes with angulated blades.[29]

Recent studies comparing the CMAC, glidescope, storz DCI with the Macintosh laryngoscope found better glottis visualization with the CMAC in comparison to the other indirect and direct laryngoscopes.[29]

Whether angulated blade videolaryngoscopes require more skill and practice to perform endotracheal intubation needs to be evaluated through larger randomized controlled trials.

The major limitation of our study is that it was conducted on manikin and not on human subjects. The results obtained from this study cannot be directly extrapolated to the human population. The simulation of difficult airway on a manikin can reproduce some aspects of difficult laryngoscopy and to some extent mimic the difficulties encountered in cervical spine patients. Another limitation of the study was that the anesthetists were not blinded to the device being used. We did not record the time of best laryngoscopic view and time taken for intubation separately. Comparison of the D-blade CMAC with other angulated videolaryngoscopes is required through larger randomized trials to prove the fact that angulation can increase the difficulty in negotiating the endotracheal tube through the glottic aperture.

However, we feel such trials can provide an initial evaluation of the device and can be a stepping stone for the future trials on the human subjects.

Conclusion

Indirect videolaryngoscopes provided better glottis visualization and 1st attempt successful intubations in comparison to the direct laryngoscopes. There was a prolongation in the intubation time with the D blade CMAC videolaryngoscope in comparison to the conventional CMAC and the direct laryngoscopes. However, as this is a manikin study the results cannot be similar in actual situations of human subjects; therefore larger randomized human trials would be required in future to verify the results of our study.

Conflicts of interest

The authors declare no conflicts of interest.

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